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Congenital Fissure of the Sternum.

OPINIONS

IN THE CASE OF

MR. EUGENE A. GROUX.

From American Medical Monthly for December, 1858.

An extremely interesting case of congenital fissure of the sternum, which offers a rare opportunity for an intimate study of the motions and sounds of the heart and lungs, has attracted the attention of the medical profession of this city during the last month. The case is one not unknown to the world of medical science, for it has been the subject of much discussion during the last few years in all the learned societies of Europe, and has been treated upon in most of the medical journals in the different cities of Great Britain and the Continent.

Mr. E. A. GROUX, of Hamburgh, in whose person this almost unique conformation of parts is observed, has been examined by over 2000 physicians of the Old World, as the album which he carries attests. In it are found the autographs of the greater lights in our profession, from St. Petersburg to Madrid, and in many instances the detailed result of a critical examination is recorded.

We have been permitted to examine this album, and to transcribe some of these opinions. As this is an instance of a most rare anatomical disposition of parts, allowing an unusual facility for examining the phenomena presented by the heart during life, we consider every opinion upon the motions and the sounds of this organ, elicited by such a case, to be worthy of a more permanent record; we therefore,

with M. Groux's permission, give here such of them as have not been already published.

Although this malformation is congenital, M. Groux was not aware of anything peculiar about it, till he was attacked by cholera, in 1849, when his attending physician detected it, and pointed it out to him. Since then it has been the subject of much scientific speculation, as the history of his presentations to the different societies and savans of all nations proves.

History furnishes but few instances of such a conformation of parts, and it is but recently that M. Groux, when on a visit to Edinburgh, found that his case was not unique.

Dr. J. Hughes Bennett, who presented him to the Medico-Chirurgical Society of that city, exhibited at the same time a pathological specimen he had taken a few years before from the body of a woman, in which the sternum was cleft; a margin of bone existing on each side, to which the ribs were attached by their cartilages. This condition of parts was not known until the post-mortem revealed it.

Harvey records the case of a young nobleman, in whose left side there was an opening, permitting the introduction of the fingers, and the examination of the heart by sight and touch. This was, however, the result of an accident, the ribs having been fractured by a kick of a horse, the injury terminating in destruction of the soft parts by ulceration, and thus opening the cavity of the thorax.

Dr. Lyons, of Dublin, in his observations on the case of M. Groux, mentions a third case, which in some respects has a more striking similarity to the one now under consideration. It occurred in a boy fourteen years old, deformed, with a lateral curvature of the spine, and consequent deviation of the ribs, some of which were imperfect. The first rib was perfect, articulating with the sternum; the second terminated at the distance of two and a half inches from the sternum, and the third, fourth, and fifth at three inches, while the rest were joined together, forming a semi-lunar arch. In the space between the ends of the ribs and the sternum, on the left side, covered only by skin, could be seen the movements of the heart and the lung.

These are the only cases known bearing any resemblance to the singular condition of parts which are to be seen in the person of M. Groux.

M. G. is about 28 years old, small in stature, but well formed. The remarkable peculiarity in his case consists in a fissure, which extends the whole length of the sternum at the median line, dividing it into two lateral halves. This fissure is of a V shape, with irregular outlines,

covered with skin, and perhaps some of the fasciæ of the thorax; having its base upwards and its apex at the ensiform cartilage, where the two halves are held tolerably firmly together by a strong ligamentous band. During natural respiration the fissure is depressed at variable depths, which can be increased by forced inspiration, giving it a concave appearance. The width of this fissure during quiet respiration is about one and a quarter inches at its upper boundary, an inch and a half upon a line with the third and fourth ribs, and a quarter of an inch at its apex. This width can be greatly diminished or increased at will by muscular effort. Through the action of the pectoral muscles, the hands joined together and pulling upon each other, the fissure is dilated to the width of about two inches and a half; while the hands being joined, and the effort being reversed—that is, pushing against each other—the fissure is lessened in width, can be closed entirely, and the edges be made to overlap even, through the influence of the deltoid and trapezii muscles. Forced expiration also increases this fissure, forced inspiration diminishes it.

Attentively examining this triangular space, a pulsating tumor is seen about its middle, on a line with the fourth rib. This is the most apparent pulsation, but there are two others in an almost vertical line with it, the one above and the other below, which can be felt; the latter is to a certain degree visible.

The motions and sounds of the heart perceived and felt in this triangular space have been the subject of the various opinions we are to give, but before we do so we must refer to other phenomena presented by this singular case.

By forced expiration, M. Groux is able to produce a large bulging tumor in the upper portion of this fissure, which upon percussion gives the clear sound of lung. This is the upper and anterior margin of the right lung, which is forced from under the margin of the right half of the sternum to fill up the fissure, giving it a convex appearance. Coughing develops this the best.

Another curious phenomenon is the wonderful power possessed by M. Groux of instantly arresting the pulsation in the subclavian and radial arteries. This is accomplished during full inspiration, the breath being held for a few moments while the lungs are full. It is probable that the apices of the lungs press upon the subclavian arteries, and in this manner obstruct the circulation.

Still another experiment which is usually shown during the examination of this singular malformation is the enlargement of the pulsating tumor at the end of expiration, the lungs being completely exhausted,

and the respiration suspended for a few moments. The tumor grows larger gradually, and the impulse of the heart is felt distinctly in the intercostal spaces of the third, fourth and fifth ribs. This is presumed to be owing to the distension of the heart by the blood during suspended respiration.

What is the pulsating tumor which is so apparent in the fissure? This is the mooted question. By some it is supposed to be the aorta, by others the right auricle, by others again the right ventricle, and by others still, the cone of the pulmonary artery or the arteria innominata.

Dr. Lombard, of Liege, who examined M. Groux in May, 1852, says, "The pulsations of the aorta were very distinct, and not synchronous with the auricle. The first were quite high, the second lower, and very visible to the eye."

Prof. Hamernik, of Prague, says, "The pulsating tumor is the right auricle, and not synchronous with the heart's apex."

Dr. Wilhelm Reil, of Halle, thus gives his opinion: "The tumor is the right auricle, because the dilatation is synchronous with the first sound of the heart, the first sound of the aorta, and the first sound of the pulmonary artery, but the radialis was a moment later."

Prof. Baumgartner, of Fribourg: "The tumor is the right auricle, because only a body with transverse muscular fibres can produce this movement."

Prof. Forget, of Strasbourg: "It seems to me beyond question that the dilatable and pulsating tumor is the right auricle: 1. Because it occupies the position of the auricle; 2. Because it dilates to a considerable degree; 3. Because this tumor increases greatly in size when the subject separates the shoulders and suspends respiration; 4. Because behind and above this dilatation at the top of the sternum another synchronous pulsation is felt much more limited, much less expansive than the first, and which appears to me to be that of the aorta."

M. Jules Beclard writes in the *Gazette Hebdomadaire* of Paris: "The right auricle forms, in fact, across the soft parts a tumor, the maximum diminution of which is synchronous with the shock of the heart against the pectoral walls, and with the arterial pulse, consequently with the ventricular contraction. * * * It results from this examination that the shock of the heart is synchronous with the ventricular systole."

M. Aran, in his remarks before the Medical Society of the Hospitals of Paris, said, "It seems to me that there can be no doubt upon the point that it is the right auricle."

M. Bouillaud states: "Fissure of the sternum, permitting the aortic pulse to be felt. The pulsations that can be touched, that can be seen by means of this fissure, are synchronous with the pulsations of the carotid artery, the subclavian, radial, &c., and with the shock of the point of the heart. This organ is well formed, the beatings are regular, of ordinary force and extent, &c."

M. Piorry—"I have ascertained that the heart is twelve centimetres in width; that it is the right auricle which beats in the place where the sternum should be, &c."

M. Pouchet, Professor of Natural History in Rouen, says: "The pulsatile tumor can be only the right auricle. This is demonstrated by the region it occupies, by its movements of expansion, and by the considerable increase it undergoes during the act of coughing, and the suppression of the respiration—phenomena which could not be observed if it was the aorta."

The late *Dr. John Snow*, of London, stated that "the motion observable to the eye in the situation of the right auricle is occasioned by the closing of the tricuspid valves during the contraction of the ventricles, which causes a momentary reflux or wave of blood into the auricle. I am of opinion that the proper contractions of the right auricle are not very apparent."

Dr. Geo. Burrows, *Dr. Wm. Baly* and *Mr. James Paget*, Physicians and Surgeon to St. Bartholomew's Hospital, London, in their opinion, state: "It seems to us most probable, that the pulse seen and felt between the separated portions of the sternum, is due to the contraction of the right ventricle, the heart being placed somewhere above and to the left of the normal position."

Dr. Ernst, of Zurich, says, in the Album, that the tumor is the right auricle, and he writes in Virchow's Archives—"It is clear that the part of the heart seen and felt contracts when it moves downwards. This motion is synchronous with the shock of the heart which is slightly felt between the fifth and sixth ribs."

Dr. Traube, of Berlin, says that the tumor is the right ventricle, because the position of the right auricle is more to the right of the median line of the sternum.

Prof. Virchow—"I think from vivisections and from anatomical and pathological specimens in which the mediastinum and the heart, in consequence of a diminution of the left pleura, are drawn more to the left side, are placed similarly to those in the case of *M. Groux*. Consequently I am obliged to believe that the pulsating tumor is a

part of the right ventricle, in the greatest expansion of which the conus arteriosus joins."

M. Marc d'Espine, of Geneva, concludes that the pulsations perceived in the middle of the sternal fissure arise from the beatings of the aorta; "considering, 1. That each pulsation which is observed in the sternal fissure follows so immediately each systolic shock of the heart, that these two movements seem synchronous. 2. That there is an interval of appreciable time between the pulsation medio-sternal which *precedes*, and that of the abdominal aorta which immediately follows. That there is too great a distance between the regions where the pulsations which we are considering are observed, and that where the ordinary beatings of the heart are observed, for the pulsations to be attributed to the systolic movement of the ventricles."

Dr. F. W. Pavy, of Guy's Hospital, writes in the Medical Times and Gazette, "The tumor occupying the position of the right auricle pulsates with the contraction of the ventricle and the production of the first sound of the heart. It rises rapidly and suddenly, and instantaneously afterwards falls with that peculiar thrill, wave or vermicular movement proceeding from above to below, which I pointed out as, at this period of the heart's action, running through the parietics of the *auricle* of the dog. It then remains at rest until again disturbed by a fresh contraction of the ventricle. From the behavior of this pulsatile swelling, so precisely corresponding to the action of the auricle in the dog, there is not a shadow of doubt in my own mind of its being formed by this portion of the heart."

Dr. Lionel S. Beale says, "that the tumor consists partly of the right auricle and partly of the right ventricle."

Dr. Francis Sibson: "The pulsating tumor at the upper part of the fissure is the aorta, and during inspiration the aorta alone is felt; but during a prolonged expiration the right auricle ascends, and it is then seen to dilate during the ventricular systole, to contract during the ventricular diastole; in fact, then, the aorta may be felt pulsating at the upper part of the fissure, moving upwards and downwards, and the right auricle may be seen at the lower part of the fissure, moving from right to left, and *vice versa*. When *M. Groux* lies on the right side, I consider that the pulmonary artery presents itself, pulsating at the left side of the lower two-thirds of the fissure; when he lies on the left side, I consider that the right auricle presents itself to a greater extent than when he stands."

Dr. C. J. B. Williams has given a lengthy opinion, which we transcribe in full:

“MOTIONS.—That the *visible* pulsation in the middle third of the sternal vacuity is chiefly seated in the right auricle, appears to me obvious from its resemblance to the same motion observed in the exposed heart of the ass, and from the fact, distinctly perceptible in slow pulsations, that the motion immediately precedes the ventricular systole, the wave of motion beginning with the auricle and rapidly passing downwards to the ventricle. In quick pulsations, the motion of the auricle is felt in the sternal space, and the systole of the ventricle as felt and heard in its region seem to be synchronous; but, I repeat, in the more deliberate movement, when the pulse ranges about sixty-five in the minute, the wave-like progression can be traced from the auricle to the ventricle, the upper margin of which sometimes comes into view at the lower portion of the sternal vacuity. To the rapid systolic movement succeeds a slow *dilatation*; and that this proceeds from the flow of blood into the auricle from the venous trunks, is made more plain by the fact, that pressure on the abdomen, which forces the blood onwards through the ascending vena cava, accelerates the expansion of the auricle. The *aorta* can be felt pulsating, more deeply seated, above the position of the auricle; and a like pulsation of the pulmonary artery may be felt through a portion of the auricle, close to the left margin of the fissure.

“SOUNDS.—The sounds accompanying the respective motions can also be distinguished with clearness only in the slow pulsations. By aid of a small flexible ear tube with a narrow pectoral end, I was enabled to hear a *distinct sound accompanying* the commencement of the auricular contraction. It is faint and short, or flapping, and ends in the less abrupt and more distinct sound of the ventricular systole. When the stethoscope is placed over the ventricle, the flapping sound of the auricle is not heard, but the ventricle swells or rolls out its peculiar sound, till it ends with the sharp click of the diastolic or valvular sound. I infer from the preceding observation, (as well as from similar ones made twenty years ago on animals,) that each movement of the heart has its proper sound; and that the reason why the auricular sound is not usually heard, is that it is too faint to pass through the intervening lung and wall of the chest.

“The *diastolic valvular or second sound* is remarkable for its clearness and loudness in this case; and on one occasion I found it *reduplicated* or double; and I had the opportunity of verifying the explanation which I gave of this double diastolic sound more than twenty years ago. When the end of the stethoscope was placed over the aorta, above the auricle, the diastolic sound was simple; but on carrying

the instrument a little downwards, and to the left, so as to cover a part of the pulmonary artery, the sound became double; the whole heart-sound being expressed by the syllables *lubb-durrrup*, instead of *lubb-dup* as usual, obviously from the two sets of valves closing in succession, not simultaneously. This want of coincidence in the closure of the aortic and pulmonary valves is only occasional, but as it often presents itself as a phenomenon of disease, it is satisfactory to be able thus to trace it to its cause.

"The only remaining observation which I have to record is that of a short rasping murmur, heard in the course of the right carotid artery, and which must be produced there, as it is not audible in the aorta or over the course of the innominata."

Dr. C. Radcliffe Hall and others of Plymwood, Torquay, state: "The most prominent pulsation is occasioned by the right auricle. It seems to us that three distinct degrees of distance of sound, indicating as many distinct sources, may be made out from above downwards; the sound over the presumed auricle being far more superficial and bell-like than either the one above (aorta,) or the one below (right ventricle.)"

Dr. J. Hughes Bennett, Edinburgh: "Has no doubt that the pulsation above is that of the aorta, the prominent undulating one in the centre is that of the right auricle, and the inferior one observable on his taking a deep inspiration is that of the right ventricle."

Dr. W. T. Gairdner, of Edinburgh, also gives a lengthy opinion, which, as it has not been published, we give in full.

"The upper *visible* pulsation (A) is auricular; probably of the right auricular appendage.

"It precedes the arterial pulse which is felt above it by a very appreciable interval.

"It precedes the apex beat by an interval appreciable, but not so easily appreciable. Care must be taken to press lightly on the pulse A, in making this observation, otherwise the ventricle is felt pulsating below what I take to be the auricle, and is of course synchronous with the apex beat.

"It precedes the lower visible pulsation (B) by an appreciable interval. The only difficulty here arises from the fact that the movement is in opposite directions. B is rather a movement of retraction than a proper pulsation.

"The pulsation A increases, and the auricle slowly fills under the eye when M. Groux suspends respiration for a time. This phenomenon, like the welling of water into a basin which fills from below, can be

easily distinguished from the protrusion of the lung which takes place when a sudden respiratory movement concurs with a closed glottis. When M. Groux coughs, the lung protrudes, but not the auricle; when he simply ceases to breathe for several seconds, without either expiring or inspiring, the auricle protrudes, but not the lung. Percussion also shows the difference between the two. This gradual filling of the right auricle when respiration is suspended, and the enlargement of its pulsations which follows, is quite in accordance with what is seen in vivisections, when partial asphyxia is gradually induced. In *forced* respiratory movement with the glottis closed, the protruded lung conceals the auricle, and interferes with the observation of its phenomena. In forced inspiration the heart is drawn back from the thoracic wall. The favorable state, therefore, for noticing the gradual filling of the auricle is intermediate.

“I presume the movement which I have called B (the lower visible pulsation) to be in connection with the systole of the right ventricle. It is only visible in full inspiration, because it requires the descent of the diaphragm to bring the heart down to the left costal margin, when this movement is observed, and it is a movement of retraction because the systole of the ventricle withdraws it from the surface. A similar movement is occasionally seen in men perfectly well formed, perhaps not in perfect health, but without marked disease of heart.

“During suspended respiration the apex beat in the usual situation becomes indistinct, and may, perhaps, finally be lost, though I have generally found it continue. At the same time a movement becomes apparent in the third, and then in the second intercostal space. This phenomenon is very curious, and well worthy the attention of physiologists. It was attributed by some of those who observed it at the Medico-Chirurgical Society here, to be an actual displacement upwards of the apex. I am rather of the opinion that it is owing to the increasing distension of the right ventricle, which throws back the true apex of the heart from the thoracic walls.

“In the strictly normal condition of parts, the same change takes place, so far as the disappearance of the true apex beat is concerned; but I have not seen the pulsation higher up except in disease. In adherent pericardium, and even hypertrophy of the right ventricle, it is not unfrequent. In M. Groux, when the heart's action is excited, it can be easily felt on deep pressure in four intercostal spaces simultaneously.

“With regard to the reduplication of the first sound which I formerly noted, I am still of opinion that it probably contains an auricu-

lar element, and is dependent on the want of synchronism between the auricular and ventricular contractions. But we are too little sure of the causes of the first sound, to allow of our speculating on the matter."

Dr. P. Redfern, of Aberdeen, says: "I conclude that at the upper part of the fissure the aorta, or one or more of its branches, may be felt; that the undulating tumor at about the middle of the sternum is the right auricle, and that the one less easily seen, lower down and to the left of the fissure, is the right ventricle.

"I believe that the pulsations of the tumor at the middle of the sternum take place first, and that they are then succeeded by the synchronous pulsations of the lower sternal tumor and of the apex.

"The lungs do not approach the middle line in inspiration in *M. Groux's* case, because of the absence of the sternum and the depression of this part of the thoracic wall at that time by the pressure of the atmosphere; the lung is forced through the fissure during expiration simply because this part of the wall is weaker than the rest. It is unsafe to draw any conclusion as to the production of emphysema from this case.

"I believe both sounds of the heart to be produced by valvular tension entirely. Unless the auricles throw the blood with force into the ventricles, the auriculo-ventricular valves could not prevent copious regurgitation. The contraction of the auricle throws the valves upwards indirectly, and *may at times* produce such tension in them as to cause the faint flapping sound which is continued and completed at the first sound by the further tension caused by the succeeding ventricular contraction. Hence the reduplication of the first sound at times heard in *M. Groux's* case, and in disease. Even in this case I see no good ground for concluding that either muscular contraction or any other cause than the valvular tension is concerned in the production of either of the heart's sounds."

Dr. Carlisle, of Belfast, writes thus: "I do not think this pulsation is caused by the right auricle, because the movements of the auricle, when viewed in the beating heart in animals of warm blood, are of a different character. In such, during the systole of the ventricles, the auricles become gradually distended with blood from the venous trunks, and just as the systole ends, a portion of the blood passes suddenly from the auricles into the ventricles, whereby the size of the former is slightly diminished, but no active contraction appears at that time to take place in the auricles, this being the period of repose of the heart. Immediately afterwards a slightly marked peristaltic mo-

tion across the auricles commences in the right auricle, at the orifices of the venæ cavæ. When this movement has reached the appendices, these suddenly contract and become flattened and somewhat hardened, and immediately afterwards the ventricles spring forward and assume the condition which denotes their systole. No movement takes place in either auricle which would cause the pulsation felt in the middle sternal region of M. Groux's case.

"I believe this pulsation to be that of the ascending aorta. If the fingers of one hand be placed along the surface of the seat of pulsation, in a line from above downwards, a single pulsation is felt by all the fingers so placed, extending from the lower to the upper boundary of the space as before described. If the ear be at the same time applied over the region of the apex and left side of the ventricular portion of the heart, the first sound and the impulse are found to be coincident with that pulsation, namely, with the augmentation in the size of the pulsating part, and the second sound coincident with the diminution in size and the receding under the fingers of the same part. If the radial artery be felt by the other hand, the pulsation above mentioned precedes the pulsation in the radial artery by an appreciable interval. For these reasons I conclude that the pulsation in question is that of the ascending aorta. It is possible that, at the lower part, the pulmonary artery, which there lies in front of the aorta, may contribute to form the pulsation, but I was unable to discriminate between the pulsation of the pulmonary artery and that of the aorta."

Dr. Charles C. King, Professor of Anatomy and Physiology to Queen's College, Galway, Ireland, says: "I am of opinion that the undulating movement from above downwards and towards the left side, and which is observable in the centre of the sternal fissure, depends upon the contraction of the right auricle of the heart, and the pulsation inferiorly and to the left side is produced by the right ventricle; its direction is upwards and to the right side; the auricular pulsation immediately precedes the ventricular. Immediately above the auricle the beat of the aorta can be distinctly felt. On placing the extremity of a small stethoscope very gently on the auricle, a single sound is distinctly heard; on pressing more firmly, the auricle, or probably its appendix, yields, and the instrument comes into close relation with the origin of the pulmonary artery and aorta, and a double sound is heard. When the heart is beating quietly and slowly, a *double second* sound is perceptible. I attribute this to the flapping

down of the pulmonic and aortic valves, not being perfectly synchronous."

Dr. Robert D. Lyons, of Dublin, Ireland, has, in a lengthy article which appeared in the *Atlantis* for July, 1858, analyzed all the motions and sounds of the heart observed in the case of M. Groux. The oval pulsating tumor he believes to be a part of the right auricle, having a single sound and a single impulse; another sound, deeper seated and double, is heard by pressing the stethoscope upon the walls over the auricle, which causes this part of the heart to recede; the first and single sound is superficial, and belongs to the auricle; the deeper seated are those of the pulmonary artery.

M. Groux has been presented to the Academy of Medicine, the Pathological Society, the German Medical Society, each of the Colleges, and to very many private societies in this city, in all of which the wonderful conformation of the thoracic walls, and the numerous experiments he shows to illustrate the sounds and motions of the heart and lungs, have elicited the greatest degree of interest.

